A New Subspecies of *Crossidius humeralis* LeConte from Texas with a Redescription of the Species

(Coleoptera: Cerambycidae)

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A recent systematic study of the species of *Crossidius* occurring north of Mexico revealed a new subspecies of *C. humeralis* from the Texas gulf coast. Discovery of this subspecies and study of more specimens of the nominate form from southeastern New Mexico provided a basis for redescription of the species and a discussion of its variability.

The taxonomic format is essentially that utilized by Linsley and Chemsak (1962) in their revisionary work on the Cerambycidae of North America. Collection abbreviations are those of Arnett and Samuelson (1969). Special thanks are extended to Mr. W. H. Tyson, Fresno, California, and Dr. J. W. Tilden, San Jose, California, for making specimens of the new subspecies available for study, and Dr. P. O. Ritcher, Oregon State University, and Mr. R. L. Westcott, Oregon Department of Agriculture, for review of the manuscript.

Crossidius humeralis LeConte

Crossidius humeralis LeConte, 1858:24.

MALE—Form robust; head pale, black or bicolored; antennae as long as or slightly longer than body; pronotum pale, immaculate or infuscated laterally, or with five black spots; elytra light brown or orange-yellow, immaculate or with sutural and humeral vittae, vittae distinct or confluent apically; venter pale to entirely black. Pronotum inflated, rounded at sides; surface with an anterior discal callosity on each side of the midline, usually with an elongate impunctate area on basal third at middle, punctures rather dense, pubescence erect or appressed. Elytral surface densely punctate, punctures decreasing in size posteriorly, clothed with short, pale, suberect or subrecumbent pubescence which may partially obscure punctation. Length: 8–19 mm.

FEMALE—Antennae reaching to apical one-third of elytra. Pronotum paler than in male and with 2, 3 or 5 spots. Elytra with sutural and humeral vittae, the latter sometimes broken into a short basal portion and an elongate apical portion, the apical portion rarely absent. Length: 9–19 mm.

C. humeralis is easily distinguishable from all other species of *Crossidius* by its unique pronotal sculpturing and pattern of elytral maculations.

DISTRIBUTION—Southeastern New Mexico, western and gulf coast region of Texas.

LARVAL HOSTS—*Haplopappus.*

This species is separable into two well defined, completely allopatric subspecies as follows:

CROSSIDIUS HUMERALIS HUMERALIS LeConte

(Figs. 1, 2)

Crossidius humeralis LeConte, 1858:24; LeConte, 1873:197; Horn, 1885:176; Leng, 1886:119; Linsley and Chemsak, 1961:48; Linsley, 1962:161.

MALE—Moderate-sized; head dark orange-red, sometimes with frons and posterior edge just in front of pronotal margin black; antennae and legs dark orange-red; pronotum orange-red, immaculate or with lateral areas clouded with black; elytra light brown or yellow-brown, immaculate, or with sutural and humeral vittae present, sutural vitta short, narrow, its width decreasing gradually to suture near or before middle, humeral vittae extending a short distance behind humeri; venter usually pale. Head coarsely punctate, densely clothed with moderately long, mostly recumbent golden hairs. Pronotum coarsely punctate, largest punctures located laterally, becoming finer and more sparse on disk, clothed with appressed golden pubescence which usually partially obscures punctures. Elytral surface rather densely punctate and pubescent. Venter moderately densely pubescent. Length: 11–19 mm.

FEMALE—Pronotum paler than in male, dorsal callosites usually darkened or black; elytra with sutural vittae frequently present, humeral vittae narrow, usually broken into a short basal portion and an elongate apical portion, the latter markings infrequently narrowly coalesced on basal sixth. Length: 11–19 mm.

Type locality: Llano Estacado, Texas and New Mexico.

DISTRIBUTION—Southeastern New Mexico and western Texas. All material examined is from New Mexico. Inclusion of western Texas as part of the range is based on a single male labeled "S.W. Texas" cited by Linsley and Chemsak (1961).

LARVAL HOST—*Haplopappus heterophyllus* (Gray).

ADULT HOSTS—Same as larval host and also *Chrysothamnus*.

FLIGHT PERIOD—Late June to early September. Most specimens examined were collected during the first two weeks of August. The earliest record seen was June 19 at four miles south of Loving, the latest September 11 at Carlsbad, both localities in Eddy County, New Mexico.

VARIATION—Diversity in prothoracic and elytral markings is exhibited by this subspecies. Prothoracic maculations of the female are usually present in the form of five black or darkened areas on the pronotum. The two anterior markings and median marking correspond with the dorsal callosities and the basal impunctate area, respectively.

A pair of vaguely dark areas, one on each side of the basal third, completes the pattern. In some specimens these two basal markings may be absent, as may be the one corresponding to the median impunctate area. The males exhibit a more variable and in some cases a more melanic prothoracic coloration. In the most reduced state the marking consists of a narrowed anterior transverse prosternal band which extends obliquely up the sides and onto the pronotal surface

just behind the anterior margin. A progressive widening of this band results in a condition in which most of the prosternal and lateral areas become black. Increased melanization of the ventral surface is accompanied by lateral infuscation of the pronotum. The dorsal markings, one on each side of the midline, frequently exhibit a bilobed appearance with the lobes partially enveloping the discal callosities. Fusion of the ventral and dorsal black areas occurs laterally on each side of the prothorax to give the appearance of a single maculation.

Geographic variation in the presence of prothoracic markings is expressed in the males examined. Individuals with immaculate pronota predominate in collections made at southerly localities, particularly in the Carlsbad and Loving areas of Eddy County, New Mexico. To the north near Roswell and Artesia, New Mexico, beetles with prothoracic markings are the most frequently observed phenotype.

Sexual dichromatism also is evident in the nature and extent of elytral markings. In the male the markings consist of short humeral and a narrow sutural vittae located on the basal half (Fig. 1). The humeral vittae are longer in the female and are usually broken into a short basal and an elongate apical portion (Fig. 2).

These markings may be present or absent, but when present their lengths vary considerably. The humeral vittae are the most frequently expressed maculations in the males at hand. Slightly over two-thirds (68%) of the specimens examined exhibit this character. The remaining 32 percent are immaculate. The sutural vittae are present less frequently than the humeral markings and are exhibited by slightly more than one-half of the males which have humeral maculations.

The humeral and sutural vittae occur more uniformly in the females and are present on nearly all specimens at hand. The elongate apical portions of the former vittae, which are not found in the males of this subspecies, are present in three-fourths of the specimens examined. These are narrowed and generally restricted to the apical two-thirds of the elytra. Approximately 10 percent of the specimens have the basal and apical segments coalesced.

The lengths and distinctness of these vittae vary dependently. Specimens displaying short, pale and vaguely defined humeral markings exhibit similar sutural vittae. Conversely, individuals with longer, blacker and well defined humeral markings display a longer and more clearly defined sutural vitta.

SPECIMENS EXAMINED—NEW MEXICO: CHAVES CO: ROSWELL, 15 mi. S., 13 August 1950, on *Chrysothamnus*, J. W. MacSwain (1 ♂, 1 ♀, UCRC); 7 mi. E., 5 August 1969, on *H. heterophyllus*, D. E. Foster, L. S. Hawkins, Jr.,

R. L. Penrose (11 ♂, 4 ♀, UICM); 6 mi. E., 5 August 1969, on *H. heterophyllus*, D. E. Foster, L. S. Hawkins, Jr., R. L. Penrose (17 ♂, 10 ♀, UICM). EDDY CO: LOVING, 2 August 1969, on *H. heterophyllus*, D. E. Foster, L. S. Hawkins, Jr., R. L. Penrose (5 ♂, UICM); 16 August 1950, on *Chrysothamnus*, J. W. MacSwain (1 ♂, UCRC); 4 mi. S., 19 June 1968, on stems and in the roots of *H. heterophyllus*, S. M. Hogue, R. L. Penrose (9 ♂, UICM); ARTESIA, 6 mi. NE., 1 August 1968, on *H. heterophyllus*, R. L. Penrose (26 ♂, 1 ♀, UICM); 5 mi. NE., 2 August 1969, on *H. heterophyllus*, D. E. Foster, L. S. Hawkins, Jr., R. L. Penrose (13 ♂, 5♀, UICM); LAKEWOOD, 1 mi. S., 31 July 1968, on *H. heterophyllus*, R. L. Penrose (6 ♂, 5 ♀, UICM); MALAGA, .5 mi. E., 2 August 1969, on *H. heterophyllus*, D. E. Foster, L. S. Hawkins, Jr., R. L. Penrose (3 ♂, UICM); 1 mi. N., 2 August 1969, on *H. heterophyllus*, D. E. Foster, L. S. Hawkins, Jr., R. L. Penrose (3 ♂, UICM); HARROAN LAKE, 2 August 1968, on *H. heterophyllus*, R. L. Penrose (1 ♂, 1 ♀, UICM); CARLSBAD, 3 August 1969, on *H. heterophyllus*, D. E. Foster, L. S. Hawkins, Jr., R. L. Penrose (8 ♂, 2 ♀, UICM); 10, 11 September 1969, on *H. heterophyllus*, R. L. Penrose (8 ♂, UICM).

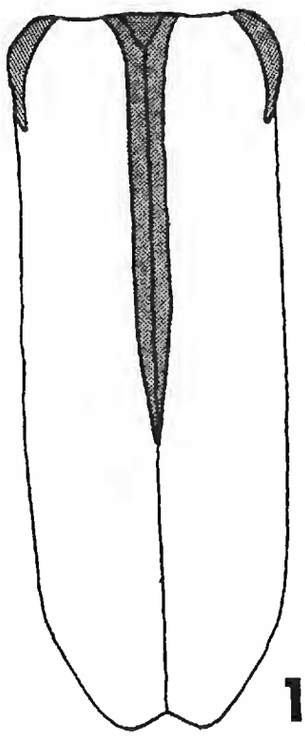
Crossidius humeralis quadrivittatus, new subspecies

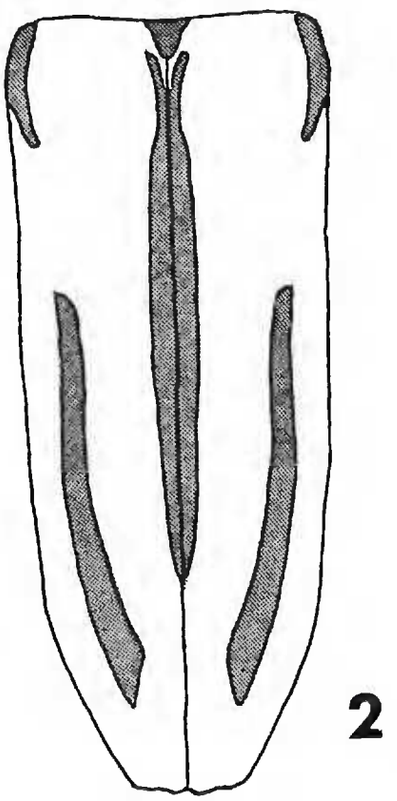
(Figs. 3, 4)

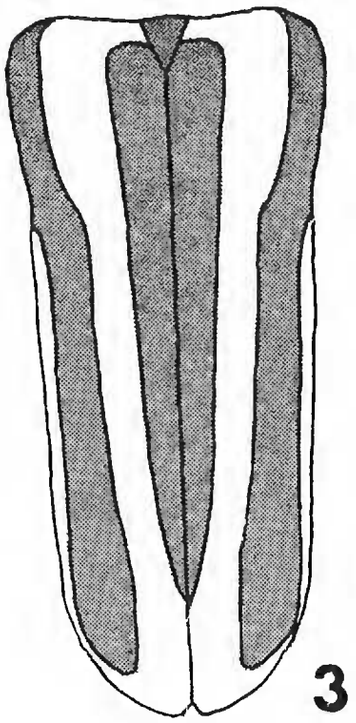
MALE—Moderate sized; head black; prothorax bicolored, prosternum with anterior two-thirds black, prosternal process and regions laterad of coxae pale, sides orange-red, each with a moderately large anterior and small posterior black spot, pronotum orange-yellow with five black spots located as follows; a large submedian pair on anterior half, two large sublateral spots and a smaller medial one on basal third; elytra orange-yellow, sutural vittae narrowed, enclosing apical portion of scutellum, gradually diminishing to suture on apical sixth, humeral vittae wide, sinuate along the basal fourth, slightly expanded apically and extending to near apex but remaining distinct from sutural vittae; appendages piceous; meso- and metathoracic sterna and abdomen prodominately black. Head densely punctate, clothed with pale, mostly erect pubescence which does not obscure the punctures. Pronotal surface moderately densely punctate, punctures contiguous and confluent, clothed with shortened, thin, pale, mostly erect to suberect pubescence which does not obscure the punctation. Elytral surface densely punctate, punctures nearly contiguous to confluent, clothed with thin, pale, mostly semi-erect pubescence which does not obscure surface features. Length: 12 mm.

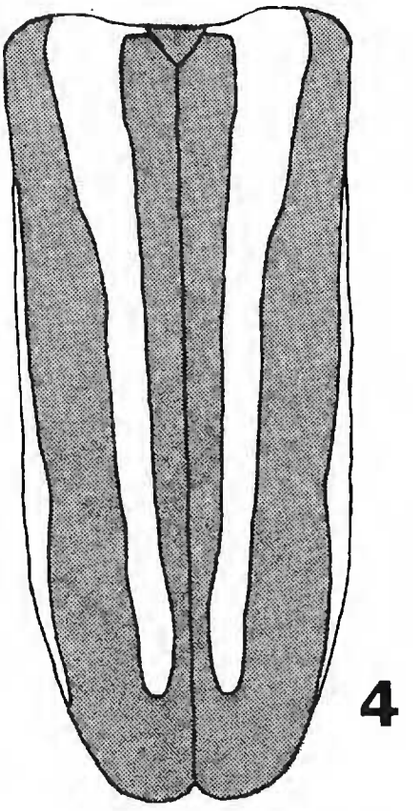
FEMALE—Prothorax with prosternum pale, sides yellow-orange, lateral spots small, vaguely defined; pronotal spots smaller than in male; elytra with sutural and humeral vittae expanded laterally, humeral vittae enveloping apex, coalesced with sutural vittae on apical sixth. Length: 14 mm.

Holotype male and allotype from WELDER [WILDLIFE] REFUGE, SAN PATRICIO COUNTY, TEXAS, 25–30 October 1968 (W. H. Tyson), deposited on indefinite loan at the California Academy of Sciences. Paratypes: (12 males, 23 females), same locality data, date and collector; (48 males, 27 females), same locality, 17 October 1970 (J. W. Tilden); (1 male), same locality, 2 November 1963 (J. W. Tilden), deposited in the collections of the California Academy of Sciences, University of Idaho, J. W. Tilden, W. H. Tyson and the









FIGS. 1–2: Elytral patterns of *Crossidius h. humeralis* LeConte. 1) male. 2) female. Figs. 3–4: Elytral patterns of *C. h. quadrivittatus* Penrose. 3) male. 4) female.

author. Additional specimens not designated as paratypes include: (1 male, 1 female), Corpus Christi, Nueces County, 10 October 1905 (F. C. Pratt); (3 males), same locality, 11 November 1969, on Compositae (C. W. Griffin); (2 males, 2 females), Arroyo City, Willacy County, 6 October 1973 (J. E. Wappes).

The type series was collected from the flowers of an unidentified species of *Haplopappus* which is presumably the larval host. *H. phyllocephalus* (Gray) is an inhabitant of the Texas coastal plain and is the probable larval host.

C. h. quadrivittatus is separable from the nominate subspecies by its black head, sparser pronotal punctation and pubescence and by its expanded, quadrivittate elytral pattern.

C. h. quadrivittatus is anatomically quite distinct and, judging from available distributional data, geographically well isolated from the nominate populations of *C. humeralis*. Treatment as a subspecies is based on the fact that character differences by which the two phenotypes can be separated are known to vary geographically in other species of *Crossidius*.

Males in the type series range from 8 to 13 mm. in length. Females from 9 to 14 mm.

Considerable variation in the prothoracic and elytral markings is evident, as in the nominate form. The pronotal spots of the female may be distinct, as in the allotype, or the large anterior and posterior spot on each side may be fused. Additionally, the pleural spots are often enlarged and quite distinct. The holotype exhibits the basic male pattern of black prothoracic markings. Most males have the pronotal and pleural spots and prosternal band expanded and fused which presents an appearance quite similar to that described for the most melanic individuals of the nominate form.

The humeral and sutural vittae are nearly always distinct in the male (Fig. 3) and always fused apically in the female (Fig. 4). In some females the widening and posterior fusion between these two vittae is extensive and the basic elytral coloration appears black with the ground color remaining as a narrow, pale, medially located vitta which tapers from the base to slightly beyond the midpoint.

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BOOK NOTICE

INSECTS IN RELATION TO PLANT DISEASE. Second edition. Walter Carter. John Wiley & Sons, Inc., New York. xiv + 759 pp. 1973. $39.50.

Although the author states that this work "does not presume to impinge on the subject matter of the highly specialized virology texts," the 431 pages comprising this last part of the book are devoted exclusively to viruses. Included are a general introduction to plant virology, followed by more detailed discussions of modes of virsus transmission, virus-vector relationships, the clinical aspects of plant virus diseases, and the ecology and control of plant viruses. The first part of the book contains separate chapters dealing with the other groups of organisms implicated in plant disease. The second part deals with various aspects of phytotoxemias. Despite the author's modest disclaimers, this text must rank as a most authoritative account of a complex, multidisciplinary subject. —EDITOR.

The Response of Tabanid Species to CO_2-Baited Insect Flight Traps in Northern California

(Diptera: Tabanidae)

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Following the initial reports of the attraction and collection of many species of Tabanidae in dry ice-baited traps (DeFoliart *et al.* 1965, Otsuru *et al.* 1965 & Wilson, Tugwell & Burns 1965), a basic objective in our 1966 studies was to determine if blood-sucking species of snipe flies (Diptera: Rhagionidae, *Symphoromyia*) also could be captured in this manner. As reported (Anderson & Hoy 1972), dry ice-baited insect flight traps of the Malaise-type were very successful in catching large numbers of *Symphoromyia* species, as well as non-bloodsucking, but host-seeking, *Cephenemyia* females (Diptera:Oestridae) (Anderson & Olkowski 1968).

In unbaited Malaise traps, Smith, Breeland & Pickard (1965) caught nearly 25 tabanids/trap (7,057 in 6 months), representing 9 species in 5 different genera. As anticipated from this and the 1965 reports of DeFoliart *et al.*, Otsuru *et al.*, & Wilson *et al.*, our experimental baiting of insect flight traps with CO_2 proved very efficient in catching many species of Tabanidae as well as many other hematophagous species in other families (Anderson & Hoy 1972). Since the success of CO_2-baited Malaise-type traps for catching tabanids was first reported (Olkowski, Anderson & Hoy 1967), several other workers also have used CO_2-baited Malaise-type traps to trap Tabanidae (Blume *et al.* 1972, Knudsen & Rees 1968, Roberts 1970, 1971, 1972, Thornhill & Hays 1972). As only a summary of our results concerning Tabanidae were reported in our 1967 abstract, and only a few species were mentioned, we herein report the complete results for comparison with later studies in California and results from other areas.

Methods

Because the primary emphasis of our research with CO_2-baited traps concerned species of *Symphoromyia*, a detailed description of the study area, etc., has been published. For details of the study area, CO_2 release and other methodology, trap design, aerial photographs

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The Pan-Pacific Entomologist 50: 255–268. July 1974

of the trap sites and deer pens, etc., readers are referred to Anderson & Hoy (1972). This research was conducted at the University of California field station at Hopland (Mendocino Co.). The topography here is characterized by rolling hills interspersed with ravines; elevation ranges from 200m to nearly 1,000m. The climate consists of winter rains and a summer drought.

All trapping was done in a woodland-grass habitat dominated by oak trees, and we used white nylon mesh insect flight traps of the Malaise-type, 2.74m high × 2.44m wide. These traps, operated from 0800 to 1700 hrs. (Pacific Standard Time), were baited with dry ice held in a polystyrene foam insulated container[3] set on the ground next to the center support pole of the trap. All traps were baited with 6.8kg of dry ice each day from 27 May through 15 June, 1966. Sublimated CO_2 escaped through 2cm holes on each side of the box. CO_2 emission rates of 2.04kg/trap/day (about 2.0 liters/min) were determined from 9-hour weight losses of the insulated boxes.

In the experimental design, each of 4 traps (I, II, IV & V) was placed in the corners of a grid about 124m on a side, and 1 trap (trap III) was set in the center of the square. A sixth trap (trap VI) was set up 0.77km SE from the center of the grid and 187m WNW from a group of penned, tame black-tailed deer (*Odocoilius hemionus columbianus*) that were observed throughout the study. This design allowed comparison of the catch of the center trap in the 5-trap grid with that caught in each of the 4 corner traps and the isolated trap VI near the tame deer.

Aerial photographs of the 5-trap grid, Trap VI and the deer pens were used to determine the percentage canopy cover within circles having radii of 5, 15, 30 and 60m from each trap site. Temperatures and wind direction and occasionally velocity[4], were taken at trap site I at 0800, 1100, 1400 and 1700 hours. These data later proved to be essentially the same as those recorded at one of the Field Station weather stations 2.4km SE of our trapping grid.

For the principal study comparing flies caught in the 5-trap grid, at Trap VI and at deer, the traps were operated from 27 May through 15 June 1966. Each day the traps were serviced in numerical order with the dry ice containers being rotated from trap to trap to avoid possible bias among different containers. On 16 June traps II, III and IV were baited with dry ice and traps I, V and VI were operated

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[3] Freez/Safe®, Mfgd. by Polyfoam Packers Div., glo-brite Foam Plastics, Chicago, Ill., U.S.A.
[4] FloRite air velocity meter, model MRF, Becharach Industrial Instrument Co., Pittsburgh, Pa., U.S.A.

without dry ice. On 17 June traps I, V and VI were baited with dry ice and traps II, III and IV were without. Between 18 June and 26 June several traps also were operated sporadically with dry ice on a survey basis. In preliminary studies in April and early May a smaller trap (1.52m wide × 1.37m high) was operated with dry ice for 10 days and for 20 days without.

At the apex of a trap flies were collected in a removable 1.4 liter styrene container through which they entered via a 15mm hole in a screen cone which formed the inner base of the collecting container. The removable collecting containers were collected and replaced with empty ones at 1100, 1400 and 1700 hrs each day, except for 4 and 12 June when they were replaced at 1.5-hr intervals (beginning after 1100 hr on 12 June). On 15 June the traps were operated for an additional period from 1700–1930 hrs.

Between 0800 and 1700 hr on each day that traps were operated, J. B. H. observed the fly activity at 4 tame deer. Various tabanid species were sporadically aspirated from, or squeezed and collected by hand from the deer. The deer were held in two pens about 20 × 70m each which enclosed the same type of woodland-grassland habitat as at the trap grid site.

All trap catch data first were assessed by analysis of variance on the basis of the completely random design. For treatments showing significant and highly significant differences, the means of different species caught at different trap sites were compared by Duncan's New Multiple Range Test (Duncan 1955). The original data from trap catches were transformed to the log $(n + 1)$ prior to conducting analysis of variance.

RESULTS

CO_2-Emission Rates. An analysis of variance (Anderson & Hoy 1972) showed that the major source of variation for CO_2 emission at trap sites was chance error (52%). Day-to-day variation (42.8%) was next, with site-to-site variation accounting for only 5.1% of the variation. There was no significant difference in CO_2 emission among trap sites or among days.

Effect of Temperature on Studies. Data on the feeding behavior of *Symphoromyia* species during 1964 and 1965 (Hoy 1966) indicated that minimum host-seeking temperatures would not be reached on days when the temperature was below 12.2°C at 0800 hr. Hence, neither host observations were made nor traps operated on 29 and 30 May and 6 June 1966. No flies were seen at hosts on 28 and 31 May nor

on 1 and 2 June; respective daily temperature maximums were 18.9, 19.4, 16.7 and 17.2°C. The 6 traps, operated for full trapping periods on 31 May and 1 and 2 June, and until noon on 28 May, caught the following tabanids: 28 May—1 *Hybomitra aasa*, 1 *Tabanus punctifer*, 1 *T. kesseli*; 31 May—1 *T. similis*; 1 June—1 *T. similis*; 2 June—1 *H. aasa*.

Numbers of Tabanids Caught in CO_2-baited Traps vs Unbaited Traps. Like other results for tabanids (Bennett & Smith 1968, Roberts 1970, Wilson, Tugwell & Burns 1966), our CO_2-baited traps caught significantly greater numbers of *Symphoromyia* species (Anderson & Hoy 1972) and tabanids than unbaited traps. Only female tabanids were caught in the traps. On the 10 days the small trap was operated with CO_2 between 6 April and 21 May, the combined catch of *Symphoromyia* and tabanids averaged nearly 25 females/day. During 20 days of operation without dry ice in April and early May this trap caught only 1 *T. similis*. When the 6 larger traps were operated with and without CO_2 on 16 and 17 June (see methods), the 3 traps baited with CO_2 caught 24 tabanids on 16 June and 33 tabanids on 17 June. The 3 unbaited traps caught only 1 tabanid on 17 June and none on 16 June.

Species Caught in CO_2-baited Traps. A total of 18 species of Tabanidae were caught in CO_2-baited traps operated between 6 April and 26 June 1966; 14 species (Table 1) were trapped during the period of the primary study shown in Table 2, one species (*H. procyon*) was caught in CO_2-baited traps operated in April and 3 species (*H. melanorhinus*, *Chrysops proclivis proclivis*, *C. furcatus*) were trapped in other studies conducted between 8 and 26 June 1966. Only *C. pechumani*, *C. hirsuticallus*, *S. gigantulus* and *A. incisuralis* were not collected between 18 and 26 June.

A total of 1094 females of 14 species of Tabanidae were caught in the 6 CO_2-baited traps during our 13 day study (Table 1) comparing catches in the 5 grid traps versus isolated Trap VI, 0.77 km away. *Silvius notatus* and *Tabanus similis* together made up 57% of the total catch, and the 4 species of which we caught more than 100 specimens each comprised 78% of the total catch.

The Relationship Between Temperature and the Tabanid Fauna Captured. The catch data in Tables 2 and 4 shows that activity occurred within a well-defined temperature range. The beginning of activity in the morning was suppressed or delayed by low temperatures, and activity usually was diminished from mid- to late afternoon and finished earlier on cool days. Joyce and Hansens (1968) also

Table 1. The species and total numbers of female Tabanidae caught at all 6 trap sites during 13 trap-days.[a]

Species[b]	Number	% of total flies caught	No. of days caught	Mean temp. ranges captured at[c]
Silvius notatus (Bigot)[d]	355	32.45	12	19.4–40.6
Tabanus similis Macquart[d]	266	24.31	13	16.7–40.6
Tabanus kesseli Philip[d]	124	11.33	13	17.8–40.6
Apatolestes comastes Brennan[d]	112	10.24	11	21.7–40.6
Chrysops surdus Osten Sacken[d]	78	7.13	10	22.2–38.3
Hybomitra aasa Philip	42	3.84	12	15.6–36.1
Chrysops coquillettii Hine	42	3.84	12	19.4–40.6
Tabanus punctifer Osten Sacken[d]	39	3.56	9	15.6–38.3
Chrysops coloradensis Bigot[d]	13	1.19	5	23.9–30.0
Silvius gigantulus (Loew)[d]	11	1.00	4	22.2–25.6
Chrysops pechumani Philip[d]	7	0.64	3	19.4–24.4
Chrysops asbestos Philip	3	0.27	3	24.4–31.7
Chrysops hirsuticallus Philip	1	0.09	1	23.9
Atylotus incisuralis (Macquart)	1	0.09	1	31.7

[a] Same dates as in Table 2.
[b] The *H. aasa* and *C. surdus* were identified by Dr. C. B. Phillip who also confirmed the identifications of representative specimens of most other species.
[c] Includes days other than the 13 primary trapping days.
[d] Species seen or collected while feeding on deer.

reported that temperature was one of the major factors affecting the activity (numbers of flies caught on traps) of *T. nigrovittatus* and *T. lineola.*

The minimum temperature threshold of host seeking activity for most species was between 20–21.7°C. Including the 4 trapping days (not included in the tables) when the daily maximum was below 19.4°C, only 2 *T. punctifer,* 3 specimens each of *H. aasa, T. kesseli* and 4 *T. similis* were captured at temperatures below 20°C. Although a few specimens of *C. pechumani* and *S. notatus* and 1 *C. coquillettii* were captured during one mid-day period having a mean temperature of 19.4°C (Table 4, and 3 June), we feel that the latter 2 species were caught during the hour when the temperature was at 21.1 and 21.7°C because none were caught during any other periods or on any days having temperatures below 21.1°C.

Overall, the smallest catches during the 13 favorable trapping days occurred on the 3 days having daily maximums below 26.7°C (Tables 2 and 4). Only *T. kesseli* and *T. similis* were caught on 7 June (Table 2). Even on warmer days only 9 specimens (including *H. aasa, C.*

Table 2. The numbers and times at which all tabanid species were caught at 6 trap sites during first 10 and last 3 trap-days.

Date	Wind[a]	Duration of trapping periods (hrs) 0800–1100	1100–1400	1400–1700	Total flies
27 May	SW	10 (12)[b]	46 (56)	26 (32)	82
3 June	NW	2 (10)	14 (70)	4 (20)	20
4 June	W	2 (1)	128 (59)	86 (40)	216
5 June	SE	11 (11)	62 (63)	25 (26)	98
7 June	SW	1 (11)	7 (78)	1 (11)	9
8 June	NW	28 (30)	46 (50)	19 (20)	93
9 June	NW	5 (6)	53 (68)	20 (26)	78
10 June	NW	1 (3)	20 (53)	17 (45)	38
11 June	N	3 (3)	44 (49)	43 (48)	90
12 June	N	24 (17)	72 (51)	46 (32)	142
Subtotals		86 (10)[c]	492 (57)	288 (33)	866
13 June	W	31 (50)	16 (26)	15 (24)	62
14 June	W	41 (55)	12 (16)	22 (29)	75
15 June	W	45 (49)	19 (21)	27 (30)	91
Subtotals		117 (51)[d]	47 (21)	64 (28)	228
Totals all days		203 (19)	539 (49)	352 (32)	1094

[a] Predominant direction from which wind was blowing.
[b] Percent of total days catch.
[c] Per cent of total flies caught during 1st 10 days.
[d] Per cent of total flies caught during last 3 days.

pechumani, *T. kesseli*, *T. punctifer* and *T. similis*) were caught during the first trapping period on the 5 days when the mean temperature for period I was 20°C or lower (Tables 2 and 4). As the mean temperature of the first trapping period increased, so too did the numbers and species of tabanids caught. Thus, during the first 10 days, except for 9 June, from 12 to 30% of a day's total catch was caught during the first period when the mean temperature was greater than 21.1°C. Maximum numbers of tabanids were caught during the first period only on the 3 days when the mean temperature for this period exceeded 24.4°C (Tables 2 and 4).

The temperature range at which all species were most active was 23.9–32.2°C, but activity seemed affected by the time of day the lower figure was reached. Thus at 24.4 and 25°C during the middle trapping period more than 50% of the day's catch was caught, but at 24.4°C during the first period only 17% of the total day's catch was caught (Tables 2 and 4). Below mean temperatures of 32.2°C most flies were

Table 3. The numbers and times at which the 5 most abundant tabanid species were caught during the first 10 and last 3 trap-days.

Date	Species	Duration of trapping periods (hrs) 0800–1100	1100–1400	1400–1700	Total Flies
27 May	*S. notatus*	7 (3)[a]	181 (72)	65 (26)	253
through	*T. similis*	26 (11)	111 (46)	106 (44)	243
12 June	*T. kesseli*	21 (19)	49 (44)	42 (37)	112
	A. comastes	12 (15)	47 (59)	21 (26)	80
	C. surdus	3 (5)	39 (68)	15 (26)	57
	Subtotals	69 (9)[b]	427 (57)	249 (33)	745
13 June	*S. notatus*	36 (35)	33 (32)	33 (32)	102
through	*T. similis*	11 (48)	4 (17)	8 (35)	23
15 June	*T. kesseli*	2 (17)	0	10 (83)	12
	A. comastes	26 (81)	4 (13)	2 (6)	32
	C. surdus	14 (67)	0	7 (33)	21
	Subtotals	89 (47)[c]	41 (22)	60 (32)	190
Total		158 (17)	468 (50)	309 (33)	935

[a] Percent of total days catch.
[b] Percent of total flies caught during 1st 10 days.
[c] Percent of total flies caught during last 3 days.

caught during the middle trapping period, regardless of temperatures (Tables 2–4), but the middle period usually was the warmest (Table 4). The usual late afternoon decline in activity of most species (Tables 2 and 3, period III) seemed related to the usual cooling temperatures during the last 2 hrs of the third trapping period. Excepting the 3 hot days of 13–15 June, on all days except 27 May and 12 June, the temperature was 20°C or lower, by 1700 hrs. On 4, 10 and 11 June, when the mean temperature of the 3rd period was nearly the same as that of the 2nd period and closer to the daily maximum than on the first 10 other days in Table 4, there was little difference in the numbers of flies caught during the 2nd and 3rd trapping periods. However, when the traps were operated for an additional period from 1700–1930 hrs on 15 June, 24 tabanids were caught during this 4th period compared to 27 caught during the 3rd period. This indicates that when temperatures remain within a favorable range activity may continue until nearly dusk.

The nearly 20% decline in numbers caught during the 3rd period as opposed to the 2nd period on 12 June, seemed associated with a temperature above 32.2°C during most of the 3rd period (Tables 2

Table 4. Temperature data for the 13 days on which CO_2-baited traps were operated in the 5-trap grid.

Date	Mean temp.[a] during 3 hr periods from:			Daily max.	Daily min.
	0800–1100	1100–1400	1400–1700		
27 May	22.2	26.1	25.0	27.8	7.8
3 June	15.6	19.4	16.7	21.7	1.7
4 June	19.4	24.4	23.9	26.7	3.9
5 June	20.6	24.4	23.3	26.7	9.4
7 June	17.8	21.1	20.0	23.3	6.1
8 June	22.2	25.6	23.3	27.2	10.0
9 June	21.7	25.0	23.9	26.7	8.9
10 June	18.9	22.8	21.7	24.4	8.3
11 June	20.0	25.0	25.6	27.2	5.0
12 June	24.4	30.0	31.7	32.8	9.4
13 June	30.6	37.8	38.3	40.0	15.6
14 June	33.9	41.1	40.6	42.8	18.9
15 June	32.8	37.8	36.1	40.6	18.9

[a] Mean temperatures were derived from the average of temperatures at the beginning and end of each trapping period.

and 4). This was the first trapping period having temperatures above 32.2°C, and as indicated by the subtotals in Tables 2 and 3 and the data in Table 4, the host-seeking activity of most species was markedly altered on hot days (13–15 June). During the middle part of hot days activity of all species was suppressed when the temperature rose above 32.2°C, but after several hours of temperatures between 32.2 to over 37.8°C most species exhibited a slight increase in activity during the 3rd period (Tables 2–4). As the temperatures of the 3rd periods on 13–15 June were nearly identical to those of the 2nd periods, the nearly normal percentage level of activity for the 3rd period (see subtotals of Tables 2 and 3) suggests that most species gradually acclimated to the high temperatures. This also is suggested by the gradual increase in numbers of flies caught from 13–15 June. But since collecting containers were only collected at the end of the period, a sudden burst of fly activity with cooler temperatures preceding sunset also was possible. All of the first 10 species in Table 1, except *H. aasa*, were collected during periods having mean maximum temperatures over 37.8°C.

The way in which the 5 most common species reacted on the 3 hot days, as contrasted with their daily activity on the 10 most productive trap days between 27 May and 12 June, is summarized in Table 3. The

Table 5. Mean number of *S. notatus* females caught per day per trap site during 13 days of trapping.[a]

Distance From Center Of Trap Site	Trap sites					
	IV	II	III	VI	V	I
	2.38	2.92	3.08	4.85	5.31	8.77
5 m	0[b]	5	0	2	51	35
15 m	0	16	0	25	70	60
30 m	14	25	4	47	55	32
60 m	26	32	12	65	45	23

[a] Totals underscored by the same line are not significantly different at the 5% level of confidence when compared by Duncan's multiple range test.
[b] Total percentage canopy cover within a circle with the indicated radius.

larger catches of *T. similis* and *kesseli* (than the other species) in the first period during the first 10 days is indicative of the lower minimum temperature thresholds at which they exhibited host-seeking activity. However, the number of *A. comastes* caught in the first period on these days (Table 3) is misleading when summarized in this manner because all 12 specimens were caught on days having a mean maximum temperature of 21.7°C, or higher, for the first period; 10 were caught on 12 June. By contrast, the first period catches of *T. similis* and *kesseli* on these 10 days were spread out over 6 and 7 days, respectively, 4 of which had mean maximum temperatures of 20°C or lower for the first period.

If one excludes the data for 12 June, then *S. notatus*, *C. surdus* and *A. comastes* all showed similar patterns of activity during the first part of the study which were different from the daily pattern of activity exhibited by *T. similis* and *kesseli* (Table 3). However, on the 3 hot days the daily patterns of activity did not fall into 2 well-defined categories (Table 3). Instead, (1) the activity of *A. comastes* was largely confined to the first period during 13–15 June, as one might have expected from its response in the first period on 12 June; (2) the principal activity of *T. kesseli* unexpectedly occurred in the 3rd period; (3) *S. notatus* exhibited a uniform level of activity throughout the day; and (4) *C. surdus* and *T. similis* exhibited bimodel activity peaks with somewhat greater activity in the first period.

Tabanids Caught at Various Trap Sites. After transformation of the numbers of the 5 most abundant species caught/trap/day to the log $(n + 1)$, analyses of variance revealed: (1) no significant difference among site means for *T. similis*; (2) a significant difference

Table 6. Mean number of *T. kesseli* females caught per day per trap site during 13 days of trapping.[a]

Trap sites[b]					
III	VI	II	IV	V	I
0.69	0.92	1.46	1.46	2.00	3.00

[a] Totals underscored by the same lines are not significantly different at the 5% level of confidence when compared by Duncan's multiple range test.
[b] See Table 5 for the total percentage canopy cover within circles having radii of 5, 15, 30 and 60 m from each trap site.

among site means for *C. surdus* and *A. comastes*; and (3) highly significant differences among site means for *S. notatus* and *T. kesseli.* For the numbers of *S. notatus* captured (Table 5, trap I was significantly different from all other traps except V and VI, but there was no significant difference among traps II–VI. For *T. kesseli* (Table 6), the number of flies caught in trap I was significantly different from only the number caught in traps III and VI, and there was no significant difference in the number of flies caught in traps II–VI. Although the more sensitive F test revealed a significant difference among trap sites for both *A. comastes* and *C. surdus*, there was no significant difference among trap site catches of these at the 5% level of confidence when compared by Duncan's multiple range test.

In contrast to the *Symphoromyia* species studied, whose catches were influenced by the percentage canopy cover surrounding trap sites (Anderson & Hoy 1972), the 4 corner traps of the grid did not significantly decrease the number of most tabanid species caught in the center trap (Trap III). Only the numbers of *S. notatus* and *T. kesseli* caught in the center trap were significantly less than the numbers caught in one of the 4 corner traps (Tables 5 and 6). Wind direction also had no marked effect on tabanid catches in different traps as it did for the *Symphoromyia* species (Anderson & Hoy 1972). Thus, the more uniform occurrence of tabanids than snipe flies in all traps probably was related to their being stronger fliers than snipe flies and to their known visual response to traps and targets of different colors (Bracken, Hanec & Thorsteinson 1962, Morris 1963, Thorsteinson, Bracken & Hanec 1965). Although white is not very attractive to most tabanids (Barrass 1960, Bracken, Hanec & Thorsteinson 1962, Hansens 1947), the contrast between the white traps and the surrounding green grass, trees and shrubs made them very conspicuous. It also is commonly known that many species of tabanids, particularly the larger ones, disperse throughout unsheltered pastures where they attack livestock.

Table 7. A comparison of tabanids caught in traps and observed at hosts from 27 May through 15 June 1966.

Fly Site	No. flies per sampling unit[a]	Adjusted no. flies per sampling unit[b]
Traps	183	183
Deer	9	18

[a] Mean number of flies/trap or host.
[b] Adjustment for hosts is 2× the actual number observed/sampling unit. This is based arbitrarily on the fact that tabanids commonly require about 4 minutes to feed (e.g. Philip 1931, and personal observations) and instantaneous fly counts were made on a host only at 10 minute intervals between 0800 and 1700 hrs.

Tabanids Feeding on Deer. Females of 9 of the 14 species listed in Table 1 fed on deer, at least occasionally. Of the more common species trapped only *H. aasa* and *C. coquillettii* were not collected from or specifically recognized when feeding on deer. None of the last 3 species in Table 1 were collected from or seen feeding on deer. *Tabanus punctifer*, readily distinguished from the other local fauna, commonly was observed feeding on deer, whereas the remaining 8 species in Table 1 all were collected while feeding on deer. A total of 37 tabanids was observed feeding on deer from 27 May through 15 June; they fed at temperatures between 21.1–37.8°C. Two specimens fed between 0800–1100 hrs, 26 between 1100–1400 hrs, and 9 between 1400–1700 hrs.

Other species caught feeding on deer were *H. procyon* in March and April, and *C. proclivis proclivis* in June. All *Chrysops* species fed on the face and ears of deer, whereas the 2 *Silvius* species most commonly attacked the rear legs. The larger, more robust *T. kesseli* and *T. punctifer* usually fed on the neck, but occasionally on the back and rarely on the side of the face. Like the *Chrysops* species, *H. procyon* fed on the faces of deer, and recently it was found to be the principal vector of the arterial worm, *Elaeophora schneideri*, to deer in the Hopland study area (Anderson & Weinmann, Weinmann, *et al.* 1973). The above feeding sites are essentially the same as those observed for related fauna in eastern Canada (Smith, Davies & Golini 1970).

Trap Efficiency for Tabanids. In general, the traps caught more tabanids than would be expected from concurrent observations of the deer. On average, a trap caught about 10 times as many tabanids as were observed at a host deer (Table 7), whereas about the same number of *Symphoromyia* species were caught in a trap as were seen at a host (Anderson & Hoy 1972). Everett & Lancaster (1968) and Wil-

son (1968) also caught far more tabanids in CO_2-baited traps than were seen attacking cattle.

With respect to the number of blood meals taken from deer in 1964 and 1965, Hoy (1966) found that tabanids were outnumbered by *Symphoromyia* species by 40 or 50 to one. On the 13 trapping days from 27 May through 15 June 1966, 1369 *Symphoromyia* species were seen feeding on deer (Anderson & Hoy 1972) versus only 37 tabanids.

SUMMARY

A total of 18 species of tabanid females was caught in CO_2-baited traps between 6 April and 26 June 1966. The baited traps caught about 10 times as many female tabanids as were observed at deer, and there were fewer significant differences among trap site catches for the most abundant tabanid species than for species of *Symphoromyia* previously studied. Wind direction and the percentage canopy cover surrounding traps had little effect on tabanid catches at various trap sites. The ratio of tabanids caught in dry ice-baited versus unbaited traps was 57:1.

Daily host-seeking activity of various tabanid species occurred within well-defined temperature ranges; for all species activity was suppressed below 23.9 and above 32.2°C. Normal host-seeking times for most species were markedly altered on hot days (daily maximum temperature above 32.2°C). Eleven of the 18 species trapped fed on deer at temperatures between 21.1 and 37.8°C; species of *Chrysops* fed on the face and ears, *Silvius* most commonly on the rear legs, *Hybomitra* on the face, and *Tabanus* on the neck, back, and rarely the face. The ratio of *Symphoromyia*:tabanid species feeding on deer was about 40:1.

ACKNOWLEDGMENTS

We thank Dr. W. M. Longhurst (University of California, Davis), Resident Zoologist, Mr. A. H. Murphy, Supervisor, and Mr. G. Connolly, Research Technician, all of the University of California Hopland Field Station, for their aid in making this study possible. We also thank Dr. H. F. Heady and Dr. D. Carneggie, School of Forestry and Conservation, University of California, Berkeley, for their provision of and assistance with aerial photographs, and Dr. C. B. Philip, California Academy of Science, San Francisco, California, who identified some of the tabanid species and confirmed the identification of most others.

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Contribution to the Bionomics of the Grape Leaffolder, *Desmia funeralis* (Hubner): A Laboratory Study with Field Observations

(Lepidoptera: Pyralidae)

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The grape leaffolder *Desmia funeralis* (Hubner), which occurs on wild grapes from southern Florida to Canada and from northeastern Mexico to the Atlantic seacoast was probably accidently introduced to California in the late 19th century (Doutt et al., 1969). Since its introduction, it has been a secondary pest of grapes in California, and in recent years has become an important pest in certain areas, particularly in the eastern San Joaquin Valley.

Barnes (1944) reported that in central California, the grape leaffolder completes three full generations per year. In favorable years, a partial fourth generation may occur. Little additional biological information concerning this insect is available. The present study was initiated to obtain life history information for use in developing pest management programs.

Methods and Materials

The insects were obtained from laboratory culture of the grape leaffolder reared on fresh grape leaves. The culture was maintained in one-gallon ice cream cartons at the San Joaquin Valley Agricultural Research and Extension Center, Parlier. An ample supply of fresh leaves was provided five times a week. Insects were reared under controlled laboratory conditions at 23.9° ± 1° C and about 35% ± 15%RH.

Eggs less than 24 hour old were obtained by placing fertilized females in ice cream cartons containing green grape shoots with two to five leaves. Mated females were released about 4 p.m. every afternoon and eggs were collected the following morning and were isolated in small plastic vials. Newly hatched larvae (less than 14 hours old) were isolated in small plastic vials supplied with about 10 one inch diameter circles of grape leaf. Observations were continued throughout the larval development and changes in the feeding habits, body measurements, molting and morphological appearance were recorded. After

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The Pan-Pacific Entomologist 50: 269–278. July 1974

larvae pupated, they were again isolated in the small plastic vials for adult emergence. Adults were fed on a 10% sugar solution and their behavior, mating, and oviposition were observed in the laboratory. Egg production data were obtained from twice daily observations of freshly emerged pairs of adults in one-gallon ice cream cartons, provided with sugar solution and fresh grape leaves for feeding and oviposition, respectively. Oviposition preference experiments were conducted by releasing pairs of males and females in the ice cream cartons provided with different surfaces for oviposition.

Field studies utilized pheromone trap and sweep samples to estimate the number of generations and daily flight patterns of the grape leaffolder. Since the discovery of a sex pheromone in grape leaffolder (AliNiazee and Stafford, 1973), the virgin female traps have become an important survey tool for detecting low populations of this insect. Field trapping studies were conducted for six months (April 15th through October 18th) using closed sticky traps (AliNiazee and Stafford, 1971). Each trap was provided with one virgin female as a pheromone source. Virgin females were fed on a 10% sugar solution and changed twice per week. Average counts from three virgin female traps are reported in this paper.

The sweep samples were collected at two hour intervals on six consecutive days in August, 1971, using an insect net with 12 inch diameter rim. Ten sweep samples were collected in each of 4 different 0.25 acre blocks. Averages of ten samples are given in figure 9.

LABORATORY RESULTS

EGG STAGE: The eggs of the grape leaffolder are deposited singly, occasionally touching each other, but mostly with some space in between. In the laboratory, eggs were laid on both surfaces of the leaves, mostly along the veins and vein angles. Both surfaces of the Thompson seedless grape leaves were equally attractive for oviposition, perhaps because the surface pubescence is less prominent in this variety. In the laboratory, almost all eggs were deposited during the dark period of a 16 hr. light 8 hr. dark cycle. This indicates that in nature oviposition occurs predominantly during the evenings and nights.

Eggs are flat, shiny, mostly round to oval in shape, measuring 0.6 to 0.9 mm in length (Fig. 1). They are loosely attached to the leaf surface. The developmental period of the eggs is correlated with temperature. Observations during the summer of 1971 indicated that under natural conditions eggs hatch in about four to seven days depending upon the weather. Under laboratory conditions the average incubation

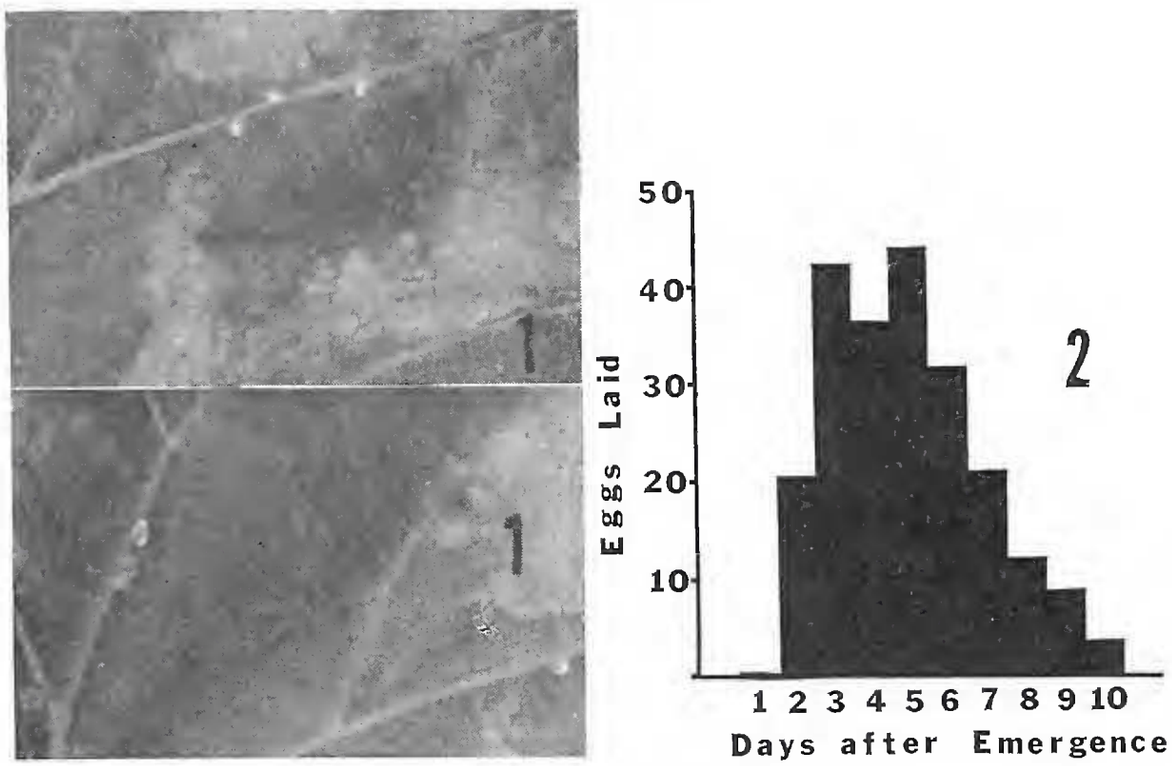


FIG. 1. Eggs of grape leaffolder. Fig. 2. Frequency of egg deposition by the grape leaffolder adults.

period was 5.3 days (range 3.5 to 9; n = 202) at 23.9 ± 1° C. About 84% of the eggs hatched within first eight days. Numbers of eggs laid by individual females varied from 6 to 431 (average 199; n = 24). A majority of the eggs were laid between the second and fifth day after emergence (Fig. 2). The average preoviposition period was 1.5 days, the oviposition period 6.7 days, and postoviposition period 1.3 days. Female moths failed to oviposit on a variety of artificial substances, including aluminum foil, plastic sheets and Saran® wrap, glass plates and smooth plywood sheets.

LARVAL STAGE: Soon after hatching, the young larvae move to protected places and feed by webbing two or more leaves, initially in groups. In the field, the leafrolls made by the earlier generations are preferred by young larvae. Laboratory observations indicate that young larvae feed between two leaves and do not make any leafrolls until they are about a week old. Initially, they make tiny leafrolls mostly towards the leaf edge and feed inside. As they grow the leafrolls are enlarged (Fig. 3) and by the time the larval development is complete, one or two leaves may be completely rolled. The density of rolls may be directly related to the population density of leaffolders. However, the ratio of rolls to stages of the insect varies with the date.

There are five larval instars. The developmental period of each instar

TABLE 1. Duration of the larval instars of the twenty-one grape leaffolder larvae reared on grape leaves at 23.9 ± 1° C.

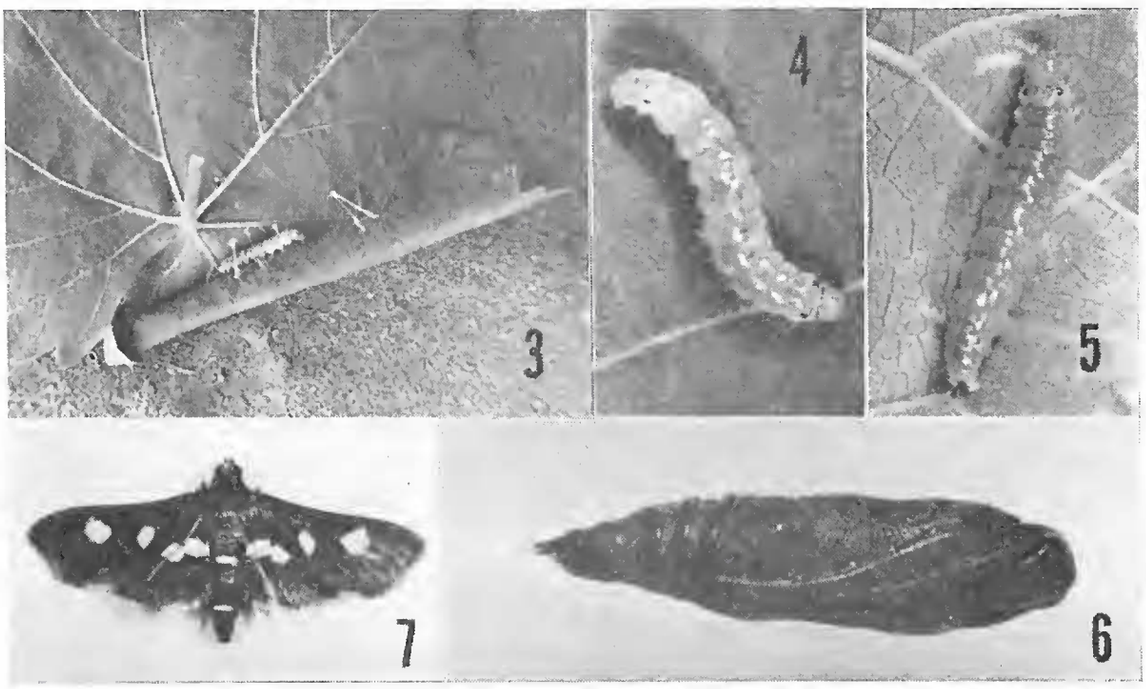
	Duration in Days		
Instar	Average	Maximum	Minimum
First	3.5	5.5	2
Second	3.9	5.5	2
Third	4.4	6	3
Fourth	4.3	7.5	3
Fifth	6.1	9	2.5

varies considerably depending upon the temperature. In the laboratory tests at 23.9 ± 1° C, the average developmental period of the first instar larvae was 3.5 days, the second instar 3.9 days, the third instar 4.4 days, the fourth instar 4.3 days, and the fifth instar 6.1 days (Table 1). The length of the larval period varied from 16 to 31 days with an average of 20.8 days.

Newly hatched larvae measure about 1.2 to 1.8 mm in length. They are creamy white to pale yellow. The second instar and older larvae are bright green to greenish-yellow. During development, the larvae develop characteristic markings that can be used to distinguish the different instars (Barnes 1944). The full grown larvae are light green and measure about 16–22 mm in length (Fig. 4). The larval feeding capacity varies in different instars and in vineyards of different varieties. Barnes (1944) reported that the larvae ate 3.34 square inches of Emperor grape foliage during their larval development. Out of this, less than 15% of the total foliage was eaten during the first three instars.

PREPUPAL AND PUPAL STAGES: After completing development, the larvae become quiescent before pupation. Towards the end of the fifth instar, larvae stop feeding and make a pocket-like case about ½ to ¾ inch long by cutting the leaves, or gluing the leaves together, and spend their prepupal and pupal stages in these envelopes. In almost all cases, a small piece of a grape leaf is cut on three sides and folded over to form an envelope. In the laboratory, paper towels which were put in rearing cages were similarly cut to form pupal cases. Sometimes, the envelopes are attached to other leaves. In the field, the envelopes fall to the ground with other foilage in late fall, and shelter the diapausing pupae until next spring.

During the prepupal stage, the larvae shrink considerably and the



FIGS. 3–7. Various instars of the grape leaffolder. Fig. 3. A leaf roll made by the grape leaffolder. Fig. 4. Mature larva. Fig. 5. Pre-pupa. Fig. 6. Pupa. Fig. 7. Adult.

body color changes from greenish-yellow to pink. Most of the prepupae observed were much fatter and shorter than the fifth instar larvae (Fig. 5). The prepupal period of 42 individuals observed in the laboratory varied from 2 to 6 days with an average of 2.7 days (Table 2).

Initially, the pupae of the grape leaffolder are light pink in color, but within a few hours after pupation they become dark brown. They

TABLE 2. The developmental period of different stages of the grape leaffolder reared on grape leaves at 23.9 ± 1° C.

Stage	Individuals Observed	Duration in Days		
		Average	Maximum	Minimum
Egg	202	5.3	9	3.5
Larval	43	20.8	31	16
Pre-pupal	42	2.7	6	2
Pupal	45	11.2	14	8
Egg to adult				
Males	32	39	54	32
Females	34	38.2	51	30
Both sexes	66	38.6	54	30

TABLE 3. Oviposition and longevity data of 22 to 26 mated grape leaffolder females maintained on sugar solution at 23.9 ± 1°C. All times in days.

	Pre-Oviposition Period	Oviposition Period	Post-Oviposition Period	Eggs/ Female	Adult longevity	
					Males	Females
Average	1.5	6.7	1.3	199	6.6	8.8
Maximum	2.5	13.5	2.5	431	12	15
Minimum	0.5	2.5	0	6	2	3

resemble the pupae of other pyralid moths and measure about 1 to 1.5 cm in length (Fig. 6). The pupal period of 45 individuals varied from 8 to 14 days, average 11.2 days (Table 2).

ADULT STAGE: Before adult emergence, the pupae wiggle vigorously and free themselves from the pocket-like pupal chamber. Soon after emergence, they move around quite a bit, probably in search of food. Under field conditions they hide in shady places underneath the vines during the daytime and begin their activities after sunset. They are medium sized black moths with patchy white spots on the body and wings (Fig. 7).

Adult longevity is dependent upon many factors including temperature and food availability. In the laboratory tests (Table 3), males fed on 10% sugar solution lived 2 to 12 days (average 6.6), while females lived 3 to 15 days (average 8.8). Adults fed on plain water did not survive as long; yet, they lived considerably longer than those provided with no water, which died in two to four days.

FIELD RESULTS

The field results were limited to study of adult behavior, daily rhythm and seasonal flight pattern.

Field observations indicate that one closed sticky trap with one virgin female as a pheromone source was much more effective than light traps. Results (Fig. 8) show that virgin female traps attracted enormous numbers of males during a five month season. Although the population of grape leaffolder varies from field to field and from year to year, the comparison of light trap catch data (AliNiazee and Stafford, 1972) with the catches of grape leaffolder in the virgin female traps definitely reflects the remarkable effectiveness of the sex pheromone traps. Also,

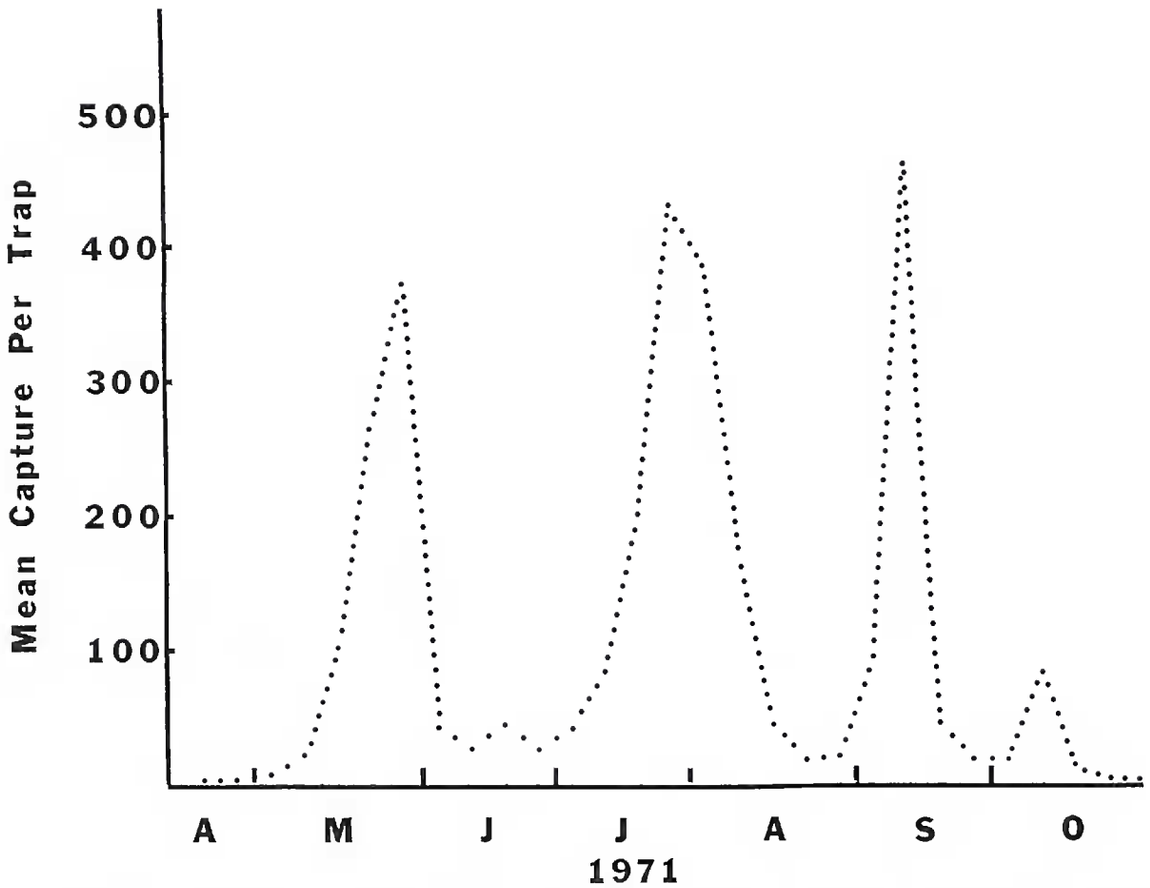


FIG. 8. Average number of adult males attracted to virgin female traps per week.

the virgin female traps were very effective in detecting low levels of moth activity.

Data presented in Figure 8 indicate that there were three population peaks during 1971. A relatively small peak occurred in October, which probably represented a partial fourth generation. The partial fourth generation may be a suicidal generation because of the lack of food availability and the onset of cold temperature regimes in late fall and early winter. Total numbers of moths collected per trap in each month of the study period indicate that the grape leaffolder population started at a lower level and then built up to a large population by the end of the season.

Adult activity during peak summer months, which determines the intensity and spread of vineyard infestations, was studied in central California vineyards. Field observations indicate that the grape leaffolder adults are nocturnal (Fig. 9). They begin their flight activity soon after sunset provided the temperature is not too high (above 32.3°C). However, the early evening flight activity is relatively insignificant. The activity increases with time, peaking about four to six hours after

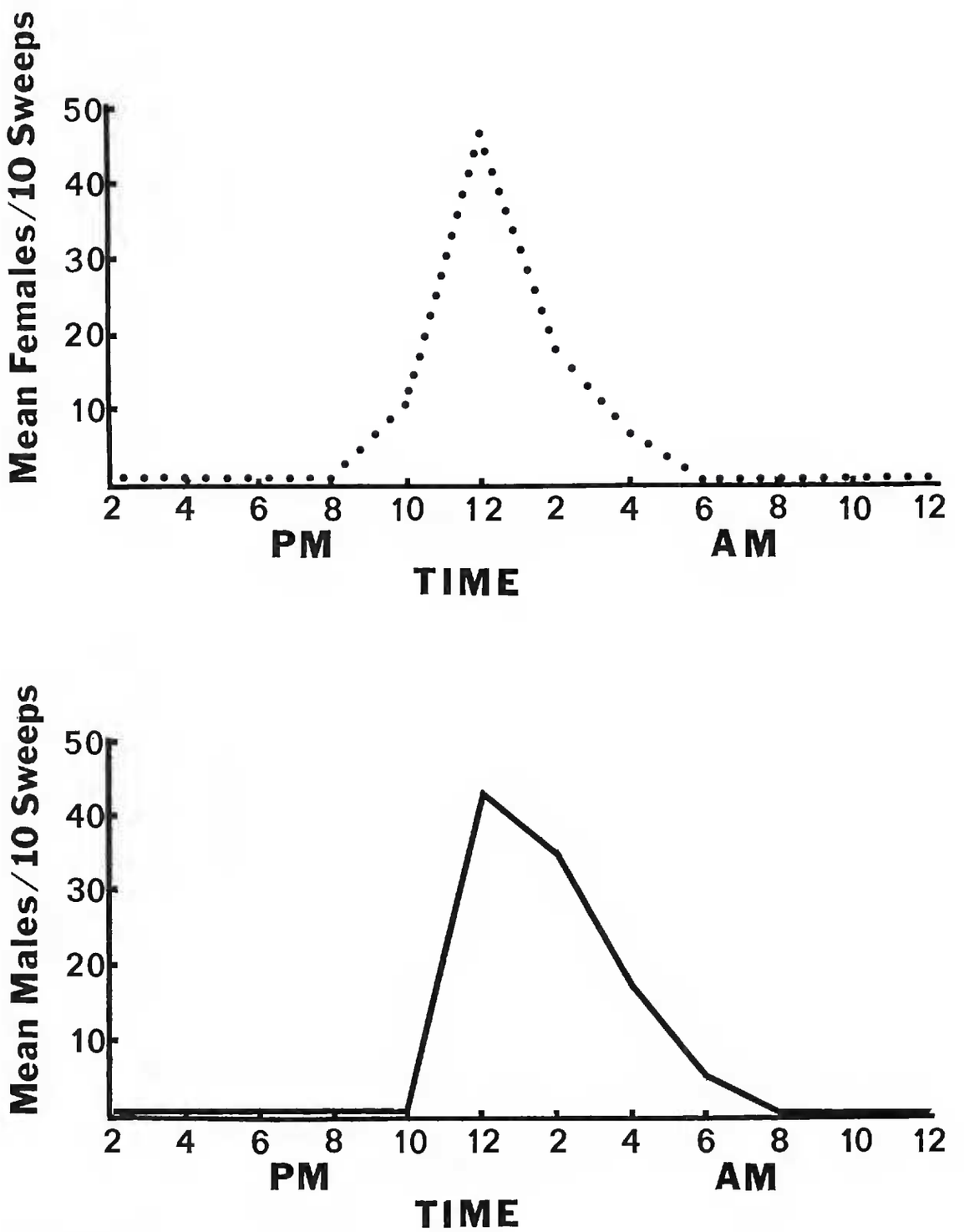


FIG. 9. Daily activity rhythm of males and females.

sunset. There were more females in the samples collected between sunset and midnight. However, about midnight the activity increased considerably and about equal number of males and females were collected in sweep net samples. Increased incidence of mating was observed about midnight and the early morning hours. At this time the male activity in the field increased and numbers of female decreased.

Adult activity continued until about 400 hours, but was mostly

dominated by the males toward the end (Fig. 9). The virgin female trap placed in the same vineyard revealed a similar situation. Male attraction to the female traps was very low for about two to four hours after sunset but increased sharply around midnight and continued until the next morning.

DISCUSSION

The oviposition record of 24 fertilized females indicates that most females started ovipositing on the second day after emergence, and a majority of them continued to oviposit until the seventh day. One female continued to oviposit until the 15th day after emergence. AliNiazee and Stafford (1973) showed that one-day-old virgin females were very attractive to males. This indicates that mating probably takes place within a day after emergence and the oviposition starts the next day.

There was little difference in the egg to adult period of males and females (Table 2). The egg-adult period of 66 grape leaffolders observed in the laboratory indicated a range of 30 to 54 days with an average of 38.6 days. The difference between the maximum and minimum length of development may explain the occasional occurrence of a partial fourth brood of the insect in the San Joaquin Valley vineyards. However, in spite of this 24-day difference in the maximum and minimum egg to adult development, a relatively high degree of uniformity of generation time is noted in the laboratory. This is also true in the vineyards where the overlapping of generations is a less severe problem than other grape insects such as the omnivorous leafroller, *Platynota stultana* (Walsingham).

The present study indicates that pheromone traps provide an improved method of monitoring activity and population fluctuations in these insects, as compared to, malt syrup traps (Barnes, 1944), light traps (AliNiazee and Stafford, 1972) or larval counts (Jensen, personal communication).

ACKNOWLEDGMENT

I am grateful to Dr. E. M. Stafford, Department of Entomology, University of California, Davis, and Mr. F. L. Jensen, UC Extension Service for their encouragement and helpful review of the manuscript.

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ZOOLOGICAL NOMENCLATURE

ANNOUNCEMENT A. (N.S.) 92

Required six-months' notice is given of the possible use of the plenary powers by the International Commission on Zoological Nomenclature in connection with the following cases:

(See Bull. Zool. Nomencl. 30, parts 3/4, 28th June 1974)

1748. Suppression of *Scoptes* Hübner/1819/(Insecta, Lepidoptera)

2042. Designation of a neotype for *Apis rotundata* Fabricius, 1793 (Insecta, Hymenoptera)

2044. Designation of type-species for *Eriophyes* Siebold, 1851 and *Phytoptus* Dujardin, 1851 (Acarina, Eriophyoidea)

2046. Designation of a neotype for *Geloïus decorsei* I. Bolivar, 1905 (Insecta, Orthoptera)

2049. Designation of a type-species for *Lonomia* Walker, 1855 (Insecta, Lepidoptera)

2055. Validation of *Nysson* Latreille, 1796 (Insecta, Hymenoptera)

2056. Suppression of *Euplilis* Risso, 1826 (Insecta, Hymenoptera)

Comments should be sent in duplicate, citing case number, c/o British Museum (Natural History), Cromwell Road, LONDON S.W.7 5BD, England. Those received early enough will be published in the *Bulletin of Zoological Nomenclature*.—MARGARET GREEN Scientific Assistant

A New Species of *Idiognophomyia* from California

(Tipulidae–Diptera)

Charles P. Alexander

Amherst, Massachusetts

I am indebted to Dr. Paul H. Arnaud for specimens of a new and interesting crane fly from southern California. The fly belongs to the eriopterine genus *Idiognophomyia* Alexander, in the New World known previously only by *Idiognophomyia comstocki* (Alexander), likewise from southern California.

The genus originally was described as a subgenus of the older *Gnophomyia* Osten Sacken (Annals Natal Museum, 13: 403–404; 1956), being based on a South African species, *capicola* Alexander. Presently there are ten species in the genus, with a very disjunct distribution, these including besides the genotype in the Ethiopian region, *ignava* Alexander; *keiseri* Alexander, and *patula* Alexander; Oriental, *brevicellula* Alexander and *vanitas* Alexander; Eastern Palaearctic, *collata* Alexander and *laterospinosa* Alexander; Nearctic, *comstocki* Alexander and *enniki* new species.

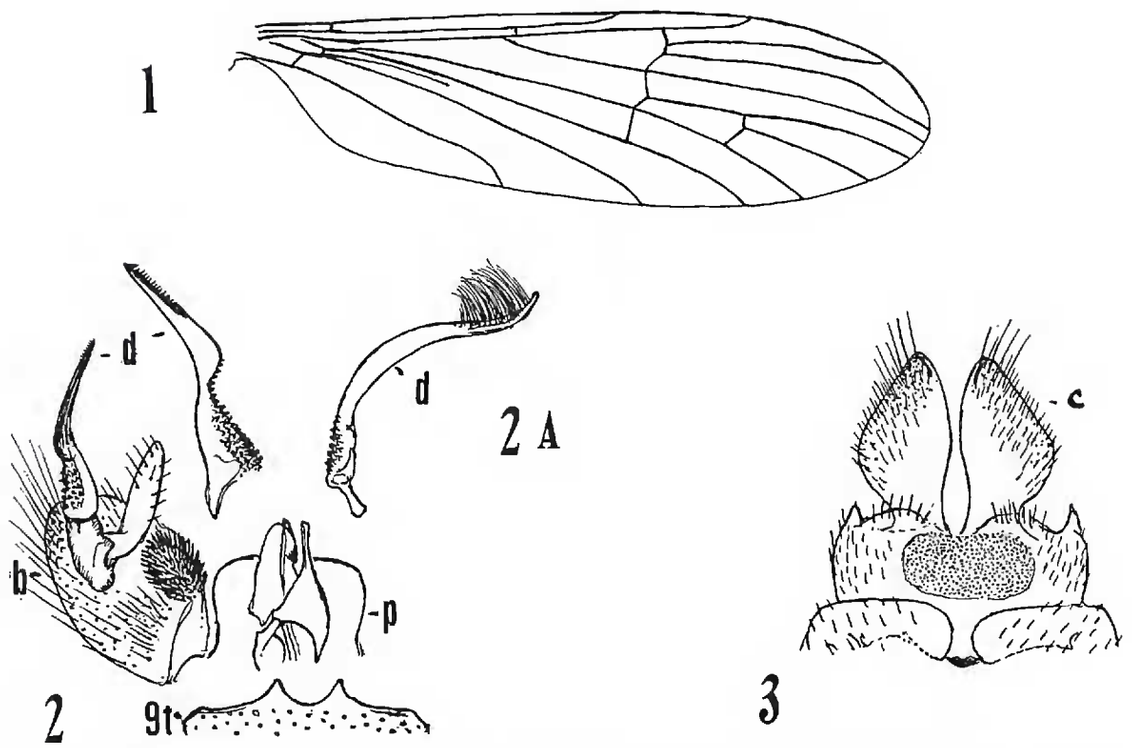
The discoverer of the new species, Franklin Ennik, found the immature stages in decaying *Yucca* and since nothing is known concerning the life histories of any other species, a further account of the larvae, pupae, habitats, and other data will be interesting and valuable.

Idiognophomyia enniki, new species

Size medium; general coloration of thorax brownish gray, pleura with broad longitudinal stripe and with a light yellow more ventral line; knobs of halteres brownish black; legs yellow, outer segments brown, legs with abundant interpolated elongate scales; wings subhyaline to weakly infuscated, stigma scarcely indicated; *Sc* relatively short, Sc_1 ending some distance before fork of *Rs*, latter in longitudinal alignment with vein R_5; *m-cu* at or close to fork of *M*; male hypopygium with outer dististyle long and nearly straight, narrowed gradually to a point, near apex with rows of microscopic blackened setulae to form short darkened ridge. Male.—Length about 5–5.5 mm.; wing 5.2–6 mm.; antenna about 1.5–1.7 mm. Female.—Length about 5.5–6.5 mm.; wing 6–6.5 mm.; antenna about 1.8–2.0 mm.

Rostrum and palpi black. Antennae black; proximal flagellar segments long-oval, outer segments longer, verticils subequal to or shorter than segments. Head brownish gray; anterior vertex broad.

Pronotum and pretergites light yellow. Mesonotal praescutum with disk almost uniformly brownish gray, stripes not clearly differentiated, lateral borders



FIGS. 1–3. *Idiognophomyia enniki* Alexander, new species. Fig. 1. Venation. Fig. 2 Male hypopygium; dorsal aspect. Fig. 2 A—Male hypopygium of *Idiognophomyia comstocki* (Alexander). Fig. 3 Ovipositor; dorsal aspect. (Symbols: *b*, basistyle; *c*, cerci; *d*, dististyles; *p*, phallosome; 9*t*, ninth tergite).

slightly paler, pseudosutural foveae large, subtriangular, shiny pale brown; scutum and scutellum brownish gray, posterior scutal lobes and apex of scutellum slightly more yellowed, parascutella yellow; postnotal mediotergite brownish gray, pleurotergite paler. Pleura above with broad brown longitudinal stripe extending from propleura to wing root, wider behind; dorsopleural region and longitudinal more ventral stripe clear light yellow, latter beginning behind darkened fore coxa, widened posteriorly, reaching abdomen and including meral region; ventral sternopleurite darker orange yellow. Halteres with stem yellow, knob brownish black. Legs with coxae and trochanters yellowed except as described; femora and tibiae yellow, extreme tips faintly darker, tarsi brown, passing into black; legs with abundant linear scales additional to normal setae. Wings (Fig. 1) subhyaline to very weakly infuscated, extreme base yellowed; stigmal region very slightly darkened to scarcely evident; veins medium brown; longitudinal veins beyond cord chiefly with conspicuous black trichia, lacking on bases of veins that comprise cell *1st* M_2; *Rs* and outer three-fourths of vein *2nd A* with trichia, lacking on *M*, *Cu* and *1st A*. Venation: Sc_1 ending short distance before fork of *Rs*, Sc_2 far retracted, shortly beyond origin of *Rs*; R_{2+3+4}, R_{2+3} and R_2 in general transversely oblique alignment; *Rs* and R_5 forming straight line; cell *1st* M_2 subequal to or slightly longer than vein M_4; *m-cu* at or shortly before fork of *M*.

Abdomen dark brown, pleural membrane narrowly yellowed; hypopygium and ovipositor yellow. Ovipositor (Fig. 3) with valves obtuse, not blackened, only feebly sclerotized; cerci, *c*, appearing as broad flattened blades, widest at near midlength, breadth about one-half length. Male hypopygium (Fig. 2) with pos-

terior border of tergite, 9*t*, transverse, with two triangular points that are separated by U-shaped emargination. Basistyle, *b*, short and stout, mesal face near base with oval group of abundant black setae. Outer dististyle, *d*, distinctive, (Fig. 2), appearing as slender rod, basal half slightly more expanded, upper margin with abundant low darkened tubercles; outer half of style a long slender straight rod, narrowed to a point, outer third with rows of microscopic blackened setulae forming short darkened ridge; inner style expanded at base, outer end more slender, narrowed gradually to the obtuse apex. Phallosome, *p*, as in fig. 2, apex of the small aedeagus very slender. The outer style is very different from that of *comstocki* which is shown for comparison (Fig. 2 A, *d*); in this latter species at the apex of the style is a conspicuous group of very long yellow setae that includes scores of filaments.

Holotype, male, 6.5 km S. of VENTACOPA, VENTURA COUNTY, CALIFORNIA, April 9, 1974 (Franklin Ennik); reared from immature stages found in decaying *Yucca whipplei*. Allotopotype, and paratypes, 48 ♂ ♀, with the types. Types in the California Academy of Sciences, five paratypes in the Alexander Collection. Larvae occurred in the moist decaying pith of the flower stalk and leaf axils of a recently dead yucca. Many cast pupal skins protruded obliquely from moist areas of the plant. Adults emerged 20–25 April, 1974, in the laboratory (Ennik, personal communication).

This distinct fly is named for the collector, Franklin Ennik. The generally similar *Idiognophomyia comstocki* is readily told by the hypopygial characters, as described. References to this latter species include the original description (Bull. So. California Acad. Sci., 46: 45–46, plate 10, fig. 5 (venation), fig. 6 (male hypopygium) 1947). It was further discussed in the author's *Crane flies of California*, Bull. California Insect Survey, 8: 120–122, fig. 382 (venation), 399 (♂ hypopygium), 400 (ovipositor); map 85 (distribution) 1967. It presently is known from Los Angeles, Santa Barbara and San Diego Counties.

Larva and Pupa of *Idiognophomyia enniki* Alexander

(Diptera: Tipulidae)[1]

GEORGE W. BYERS

The University of Kansas, Lawrence, Kansas

Idiognophomyia enniki Alexander (1975), the second known nearctic species in its genus, was recently reared from larvae and pupae collected in southern California by Dr. Franklin Ennik. The insects were discovered in decaying Yucca, near U.S. highway 399, about five miles southeast of Ventucopa in western Ventura County, Los Padres National Forest, on 9 April 1974.

Immature forms of *Idiognophomyia* have not heretofore been known from any part of the wide range of the genus. The descriptions below are based upon 17 larvae (of which three are somewhat damaged), 12 intact pupae and 31 cast pupal skins. Most measurements are given as means followed by ranges and are derived from intact specimens only. I am indebted to Dr. Ennik and to Dr. Paul H. Arnaud, Jr., of the California Academy of Sciences, for making these specimens available to me for study.

FOURTH INSTAR LARVA

(Figs. 1–7)

Body elongate, subcylindrical (Fig. 1), about 11.5 mm long (10.2–13.0 mm) with head extended, greatest diameter approximately 1.2 mm (1.0–1.3 mm) at fourth abdominal segment, tapering slightly toward either end, dorsoventral diameter slightly greater than transverse diameter throughout. Color generally pale yellowish to light yellowish brown. Integument unevenly covered with minute, appressed yellowish hairs, giving it a silky sheen, hairs longest across posterior dorsum of abdominal segments, particularly seventh; no conspicuous setae. Creeping welts on abdominal segments 2–7 comprising 32 to 36 generally parallel (sometimes interrupted, dividing, or merging), fine, transverse ridges bearing yellowish brown hairs directed caudad.

Spiracular disc (Fig. 2) surrounded by five obtuse but distinct lobes directed backward and outward. Disc marked with densely sclerotized, black spots having granular appearance in reflected light; median dorsal spot truncated to slightly emarginate dorsally; lateral spots in broad contact with spiracles but not surrounding them; ventrolateral spots each divided by pale middle zone except for slender distal connection. Spiracles separated by distance equal to or usually slightly more than their diameter. Peripheral hairs usually bent somewhat cephalad (away from face of disc). Anal gills (Fig. 3) together a subquadrate, whitish structure when

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[1] Contribution no. 1572 from the Department of Entomology, University of Kansas, Lawrence, Kansas 66045.

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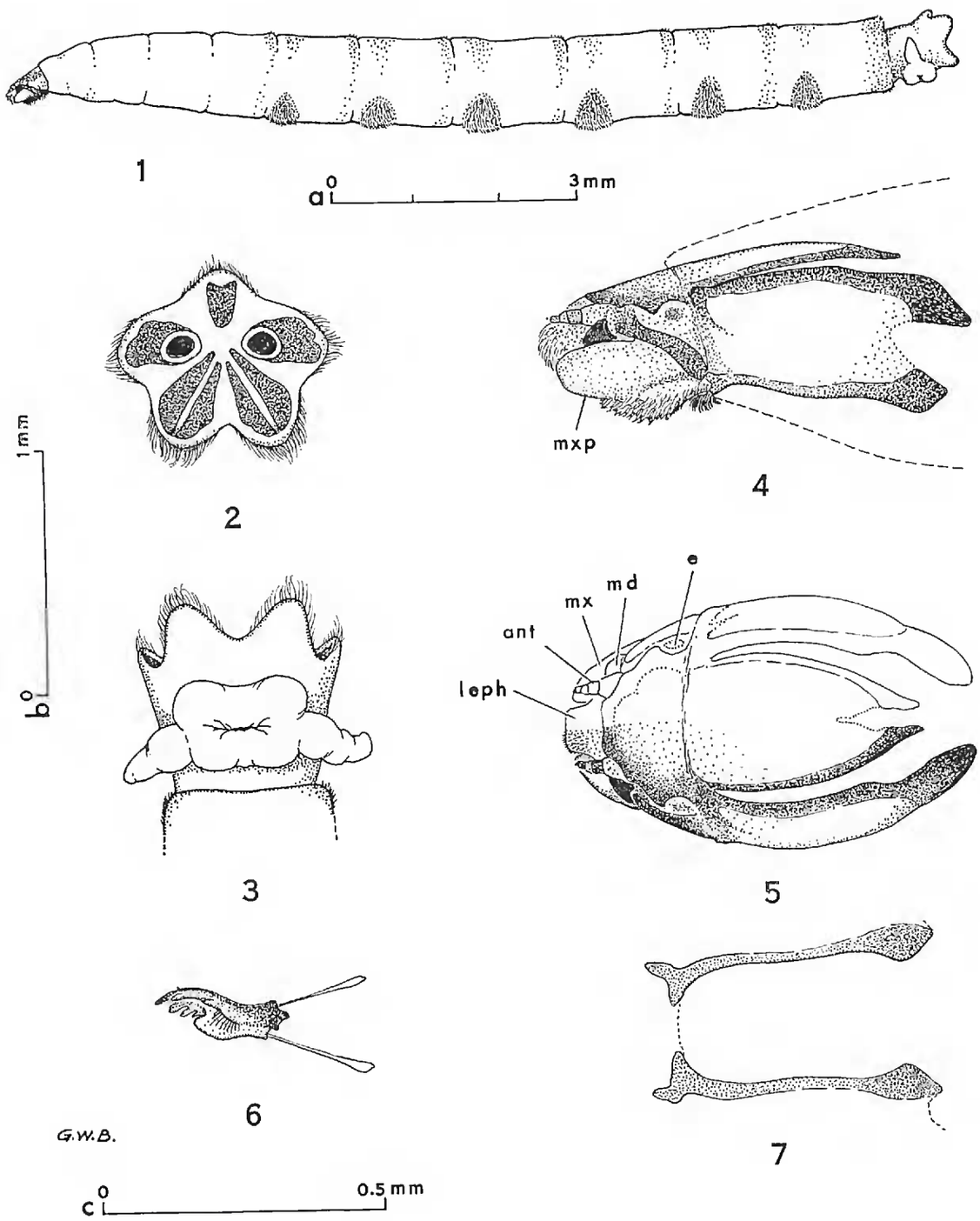

FIGS. 1–7. Larva of *Idiognophomyia enniki* Alexander. Fig. 1. Entire larva, left lateral aspect. Fig. 2. Spiracular disc, caudal (posterodorsal) aspect. Fig. 3. Terminal abdominal segments, ventral aspect, to show fully everted anal gills. Fig. 4. Head, left lateral aspect; dashed line indicates extent of removed prothorax, mxp—maxillary palp. Fig. 5. Head, dorsal aspect, shaded to indicate degree of sclerotization on lower half only; ant—antenna, e—eye, leph—labrum-epipharynx, md—mandible, mx—maxilla. Fig. 6. Right mandible, mesal aspect, with tendons of abductor and adductor muscles attached. Fig. 7. Ventral bars (darkly sclerotized lower edges) of lateral plates, bordering occipital foramen, ventral aspect, to show partial convergence at anterior ends (at left) but absence of hypostomal bridge. Scale a—Fig. 1; scale b—Figs. 2–3, 7; scale c—Figs. 4–6.

not everted, with short, blunt lobe extending up around each side of eighth abdominal segment when fully everted.

Head roughly oval in dorsal outline (Fig. 5), somewhat depressed (Fig. 4), about 0.78 mm long (0.76–0.80 mm). Posterior incisions deep, extending forward almost to level of attachment of skin (Fig. 5). Dorsal plate (fronto-clypeus) and lateral plates densely sclerotized at margins, only slightly sclerotized centrally, giving appearance of six curved, posteriorly spatulate bars extending backward from attachment of skin into prothoracic segment (Figs. 4, 5). Labrum-epipharynx (leph) a broad lobe covered with yellowish hairs curving forward and downward; clypeus densely sclerotized at anterior margin. Antennae (ant) with two distinct sclerotized segments. Maxillary palp (mxp) large, pale, projecting forward; galea and lacinia represented by dense brushes of yellowish hairs concealing two sclerotized pegs; maxilla hinged along blackened, somewhat curved sclerite before and below eye (e). Mandibles (md) intensely sclerotized at bases, convergent beneath epipharynx, each with six blunt-tipped, flattened teeth, a rounded basal lobe, and linear mesal brush of fine hairs (Fig. 6). Hypostomal bridge (maxillary plate or mentum of some authors) incomplete, the small processes not toothed anteriorly (Fig. 7); a median tuft of dense yellowish hairs spanning gap between hypostomal processes. Hypopharynx supported by a somewhat U-shaped, sclerotized bar and covered anteromedially by densely set yellowish hairs.

PUPA

(Figs. 8–15)

Male pupa approximately 6.5 mm long (6.3–7.0 mm); female about 6.8 mm long (6.4–7.4 mm); curvature of abdomen variable. Most specimens noticeably dorsoventrally flattened, and those not so depressed may have post-mortem distension in preservative. Pupal skin tinged with light brown, nearly transparent. In intact pupae, head and thorax, including wings and legs, progressively darkening with age, from pale brown to nearly black; abdomen similarly darkening to yellowish brown, a little darker on terminal (eighth and ninth) segments.

Head flattened anteriorly, impressed slightly above base of rostrum (Fig. 9). Cephalic crest in form of two broadly rounded ridges separated by a narrow median ridge, extending from above antennal bases on frons over vertex almost to pronotum; a prominent seta on broad, low tubercle on outer slope of each lateral ridge behind antennal scape (Fig. 10). Antennal sheaths extending to femorotibial joints of middle legs, without setae. Labral sheath somewhat prolonged, beak-like, completely separating sheaths of labellar lobes. Sheaths of maxillary palps more than twice as long as greatest width, their tips not recurved.

Thorax 1.0 to 1.2 mm wide, slightly narrower than anterior abdominal segments, depressed, without conspicuous rugosity or spines. Wing sheaths short, extending slightly beyond mid-length of second abdominal segment (Fig. 9), with longitudinal corrugations corresponding to major wing veins (more or less entire venation

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FIGS. 8–15. Pupa of *Idiognophomyia enniki* Alexander. Fig. 8. Entire pupa, left lateral aspect, showing darkening of head, thorax and cauda associated with maturity (i.e., advanced development of pharate adult within). Fig. 9. Anterior